

## FY17 GRC: Frequency Selective Reflector Antenna

Completed Technology Project (2016 - 2017)



## Project Introduction

Frequency Selective Surfaces (FSS) are an electromagnetic structure where a relatively thin, periodic, conductive material is designed as a spatial filter of electromagnetic waves; certain frequencies are reflected by the surface, while other frequencies are passed through the surface. The vision of this proposal is to develop a FSS specifically tailored for use in a novel, potentially high-impact FSS reflector antenna concept that would enable Ka-band multiple access system for NASA's next generation Tracking & Data Relay Satellites (TDRS) and could drastically reduce the size, weight and cost of commercial SATCOM systems. The antenna concept consists of a series of stacked parabolic reflectors, each of which is constructed of a specially designed frequency selective surface. By carefully selecting the cutoff frequencies of these surfaces, each reflector in the series is able to direct a sub-band of frequencies to a different coverage area coincident with the pointing of that particular reflector. For example, in the picture above, the first reflector in the series (purple) is comprised of an FSS which reflects the lowest of the frequency band directly forward. Higher frequencies are passed through this first surface, at which point the second reflector (light blue) is designed to reflect the next sub-band to the left, but continue to pass the higher bands. Lastly, the final reflector in the series (dark blue) receives only the highest sub-band of frequencies, and reflects them to the right. Currently, to achieve multiple coverage areas like this requires an equivalent number of multiple reflectors, each with its own feed antennas, amplifiers, mixers, filters, etc. Alternatively, a single reflector could be paired with many multiple offset feeds, but this still requires redundant RF electronics for each feed. By unifying the distinct reflectors into a single collocated reflector, a single feed and amplifier can be used, and the cost, weight, and size of the overall system is reduced several times over. Accordingly, this proposal seeks to engineer this union of FSS and reflector antenna design, which, if successfully integrated, would have wide-reaching impact in the SATCOM arena. The goal is to advance the FSS Reflector Antenna design by demonstrating a proof-of-concept FSS that can meet the performance specifications required to successfully implement the antenna, including a sharp filter cutoff (high quality factor, or Q and reasonable angular response.

## Anticipated Benefits

Should this technology be successfully matured to a functional FSS Reflector Antenna design, it would have wide-reaching impact across NASA and the SATCOM industry. This technology has the potential to enable Ka-Band multiple access on the next generation TDRS, and commercial applications also abound. The current state of the practice for achieving multiple coverage areas requires either multiple feed systems, each with their own amplifiers, mixers, filters, etc. The potential impact of this work is in combining the separate reflectors into a single structure, allowing for a single feed and amplifier to be used while still forming multiple spot-beams with the FSS



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## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Center / Facility:

Glenn Research Center (GRC)

### Responsible Program:

Center Innovation Fund: GRC CIF

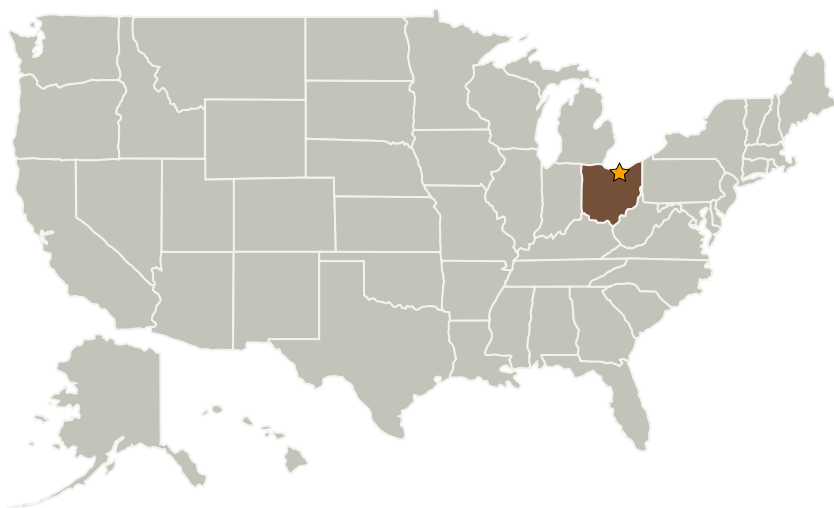
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design, drastically reducing the cost, weight, and size of the overall system; reductions could ultimately be achieved up to a factor of N, where N is the number of original reflector systems. This impact can be considered from two points of view. The first is that, as compared to existing systems, this technology has the potential to either reduce overall cost by a factor of N if existing multiple-feed systems are reduced to a single feed. The second point of view, however, is that it has the potential to increase performance by a factor of N if existing systems maintain their number of feeds/reflectors but are augmented with the FSS reflector design to multiply the number of spot-beams. In NASA's case, the latter has the potential to enable TDRS Ka-Band multiple access and achieve full earth coverage, while industry may be more interested in the cost savings of the former.

## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio

## Primary U.S. Work Locations

Ohio

## Project Management

**Program Director:**

Michael R Lapointe

**Program Managers:**

Kurt R Sacksteder

Gary A Horsham

**Project Manager:**

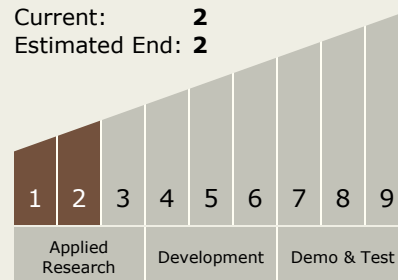
Gary A Horsham

**Principal Investigator:**

Michael J Zemba

## Technology Maturity (TRL)

Start: 1  
Current: 2  
Estimated End: 2



## Technology Areas

**Primary:**

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.2 Radio Frequency
    - TX05.2.6 Innovative Antennas

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### Target Destination

Earth